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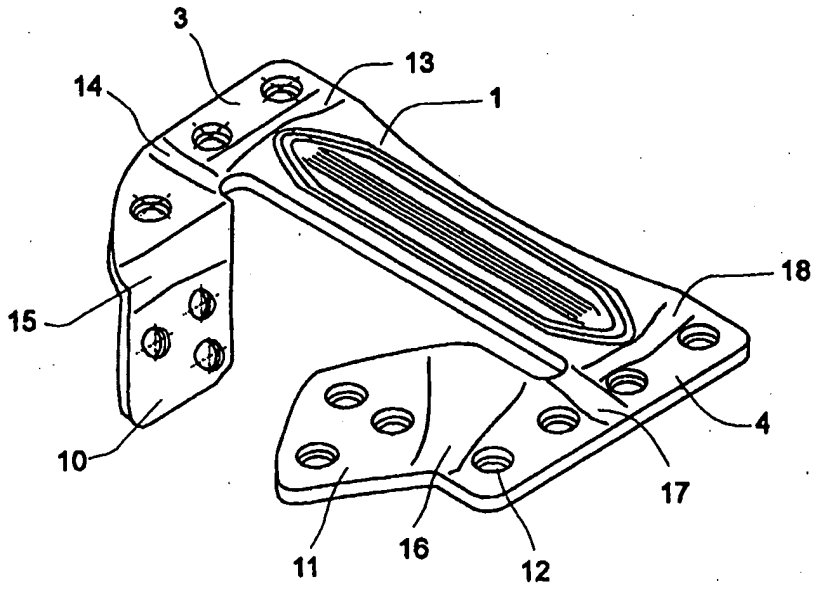
(54) Title: A MODULAR IMPLANT FOR PELVIS RECONSTRUCTION

(57) Abstract

This invention is an implant and method for reconstruction of a pelvic region. The implant including: (a) a main surface portion (1) for connecting a first and second portion of the pelvic region; (b) at least one end surface (3) connected to the main surface; (c) at least one bending zone (13–15) for changing the orientation of the at least one end surface relative to the main surface; and (d) at least one cantilever element (10) connected to the at least one end surface. According to a second embodiment the implant further includes an acetabular cup prosthesis, and additionally includes a method of (a) resecting a pelvic bone; (b) shaping a flexible template to connect selected remaining portions of the pelvic bone; (c) shaping a pelvic implant according to the template by a bending tool means; and (d) connecting said implant to the selected remaining portion of the pelvic bone.



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A MODULAR IMPLANT FOR PELVIS RECONSTRUCTION

FIELD AND BACKGROUND OF THE INVENTION

The present invention relates to a modular implant for pelvis reconstruction and, more particularly, to a versatile implant which can be adapted to a specific patient during a real-time operation.

Implants for pelvis reconstruction are widely used in orthopedic oncology. Such implants are often used in cases of bone and soft tissue sarcomas located in or around the pelvis, and in cases of metastatic bone disease (M.B.D.).

The prior art discloses a variety of pelvic endoprostheses specifically adapted for replacement of a selected portion of a patient's pelvis, depending on the site of origin of the tumor and the location of metastases. Such pelvic endoprostheses may be adapted to replace selected portions of the ilium, sacrum, acetabulum ,ischium and pubis of the patient.

Most of the implants currently used for the replacement of pelvic parts between the acetabulum and the sacrum of a patient usually feature low bio-mechanical stability and integrity owing to their flat configuration. Currently, such configuration is the most commonly used since it makes it possible to immediately transplant the implant without the need to specifically pre-design the implant to a specific patient.

The flat configuration of the currently used implants is mechanically unfavorable since it fails to provide firm and stable long-term connection to the pelvis and sacrum of a patient, mainly because such portions of the patient's body feature a complex three dimensional configuration. The load on the screws connecting such implants to the bone surfaces of the pelvis and sacrum is not distributed in an optimized manner, exposing the screws to harsh transverse forces which decrease the long-term bio-mechanical stability, integrity and durability of the implant.

Various attempts have been made to design pelvic implants of a three dimensional configuration specifically adapted for a specific patient (customized implants) so as to provide better bio-mechanical stability and integrity to the complex bone-implant. Most of these implants are tailor-made by using methods of precision casting.

Further, various attempts have been made to design three-dimensional pelvic endoprostheses for total hip replacement, wherein the proximal femur and the periacetabular area of the patient have to be reconstructed.

However, such implants can be made only after the precise boundaries of the malignant areas have been determined. The preparation of such implants usually takes between four to six weeks. Such a waiting period may be too long for a patient with a failing pelvis due to a metastatic bone disease. Moreover, since the dimensions and shape of such implants are not changeable, the implant may become unsuitable for implantation after that period of time owing to progress of the disease. Furthermore, the production method of precision casting is complex and expensive.

There is thus a widely recognized need for, and it would be highly advantageous to have, a modular versatile implant for pelvis reconstruction which can be adapted to any specific patient during a real-time operation. It would be further advantageous to have a versatile implant capable of adopting a desired three dimensional shape by changing the orientation of its surfaces. It would also be advantageous to have an implant whose shape can be determined and formed real-time in an operation so as to allow immediate transplantation. It would be further advantageous to have such an implant which has favorable mechanical features. It would be further advantageous to have an implant which allows a reliable, firm and stable long-term connection to the bone surfaces of a patient, and which is prepared by using simple and inexpensive production methods.

SUMMARY OF THE INVENTION

According to the present invention there is provided an implant for replacement of a region of a pelvic bone, preferably between the acetabulum and the sacrum of a patient, including: (a) a main surface for connecting a first portion of the pelvic area and a second portion of the pelvic area; (b) at least one end surface connected to the main surface; and (c) at least one bending zone for changing the orientation of the at least one end surface relative to the main surface.

According to further features in preferred embodiments of the invention described below, the implant may further include: (a) at least one cantilever element connected to the at least one end surface; and (b) at least one bending zone for changing the orientation of the at least one cantilever element relative to the at least one end surface.

Each of the cantilever elements may include at least one bending zone for changing the orientation of a portion of the cantilever element.

Specifically, the implant may include a first cantilever element connected to a first end surface and a second cantilever element connected to a second end surface, the first cantilever element for connection to an acetabulum of a patient and the second cantilever element for connection to a sacrum of a patient.

According to still further features in the described preferred embodiments, the end surface may be bent along any line within the limits of the bending zone so as to form an angle of between about 0 and about 30 degrees with the main surface.

The cantilever element may be bent along any line within the limits of the bending zone so as to form an angle of between about 0 and about 30 degrees with the end surface.

Further, a portion of the cantilever element may be bent along any line within the limits of the bending zone so as to form an angle of

between about 0 and about 90 degrees, or alternatively, between about 0 and about 120 degrees with the rest of the cantilever element.

According to still further features in the described preferred embodiments, the implant includes a stiffening rib. The stiffening rib may feature a convexo-concave shape in cross section.

An implant according to the present invention further includes holes for connecting the implant to the bony surfaces of the pelvis of a patient, preferably by means of screws.

Further, an implant according to the present invention may include an extension extending substantially along the longitudinal side of the main surface, the extension being oriented so as to form a predetermined angle with the main surface, thereby forming a stiffening crest between the main surface and the extension.

Further, the extension may feature a longitudinal bend extending along its longitudinal axis, the bend defining a first portion and a second portion of the extension such that the second portion being oriented so as to form a predetermined angle with the first portion, thereby enabling to substantially enclose a portion of the patient's pelvis.

An implant according to the present invention may further include openings for receiving a thread therein so as to allow to suture patient's muscles to said implant.

Further according to the present invention there is provided a bending tool for bending a pelvic implant, comprising: (a) an accommodating member having a slot for receiving a surface of the implant therein; (b) a bending member having at least one bending extension for bending a portion of the surface, the accommodating member featuring a convex surface and the bending member featuring a concave surface so as to allow sliding of the bending member over the accommodating member.

Further according to the present invention there is provided an implant for replacement of a pelvic bone by connecting a first portion and a second portion of the pelvic bone, comprising: (a) a cup acetabular prosthesis; (b) a first main surface for connecting the first portion of the pelvic bone to the cup acetabulum prosthesis; (c) a second main surface for connecting the second portion of the pelvic bone to the cup acetabulum prosthesis, wherein each of said first and second main surfaces includes: (i) at least one end surface connected thereto; and (ii) at least one bending zone located between the main surface and the at least one end surface for changing the orientation of the at least one end surface relative to the main surface.

Further, the at least one end surface may include at least one circumferential protrusion, the at least one protrusion including a hole for receiving a screw therein, the at least one protrusion including a bending zone for individually bending the at least one protrusion relative to the at least one end surface.

Preferably, the first main surface is connected to the cup acetabulum prosthesis by means of a first adapter, and the second main surface is connected to the cup acetabulum prosthesis by means of a second adapter.

According to still further features of the invention described below, the cup acetabulum prosthesis includes a protrusion, and at least one of the adapters includes a depression for accommodating said protrusion therein, such that the protrusion is movable within the depression, thereby allowing to change the orientation of the cup acetabulum prosthesis relative to the at least one adapter. The implant may include a lock screw for fixing the position of the cup acetabulum prosthesis with relation to the at least one adapter. Further, the first adapter is preferably movable with relation to the first main surface.

Preferably, the first portion of the pelvic bone includes the patient's ilium. Alternatively, the first portion of the pelvic bone includes the patient's sacrum. Preferably, the second portion of the pelvic bone includes the patient's pubis.

Further according to the present invention there is provided a method for reconstructing a region of a pelvic bone, comprising: (a) resecting a portion of the pelvic bone; (b) manually shaping a substantially flexible template so as to so as to connect selected remaining portions of the pelvic bone; (c) substantially immediately shaping a pelvic implant according to the shape of said template by means of a bending tool; and (d) connecting said implant to the selected remaining portions of the pelvic bone.

The present invention successfully addresses the shortcomings of the presently known configurations by providing a modular versatile implant for pelvis reconstruction capable of adopting a desired three dimensional shape by changing the orientation of its surfaces. Thus, the shape of such an implant can be determined and formed during a real-time operation, thereby allowing immediate transplantation. Such an implant has favorable bio-mechanical features since it provides an optimized distribution of load on the screws connecting the implant to the bony surfaces of the pelvis, thereby not exposing such screws to harsh transverse forces which decrease the long term stability and durability of the implant.

The present invention discloses a novel modular implant for pelvis reconstruction. While using an implant according to the present invention, the exact size and three-dimensional shape of the implant required for a specific patient is determined during surgery by means of a template which is easy to bend and is identical in shape and size to the required implant. The template is shaped by the surgeon so as to fit the exact dimensions of the pelvic area of a given patient after resection. The implant is then shaped according to the template by using a hand bending tool.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is herein described, by way of example only, with reference to the accompanying drawings, wherein:

FIG. 1 is a perspective view of an implant according to the present invention before adopting its three dimensional conformation;

FIG. 2 is a partial cross sectional view across line A-A in FIG. 1;

FIG. 3 is a perspective view of an implant according to the present invention while adopting its three dimensional conformation;

FIG. 4 is a schematic view of an implant attached to a pelvic girdle of a patient;

FIG. 5 is a cross sectional view across line B-B in FIG. 4;

FIG. 6 is a top view of another embodiment of an implant according to the present invention;

FIG. 7 is a cross sectional view across line A-A in FIG. 6;

FIG. 8 is a top view of yet another embodiment of an implant according to the present invention;

FIG. 9 is a cross sectional view across line D-D in FIG. 8.

FIG. 10 is a schematic view of a bending tool according to the present invention;

FIG. 11 is a cross sectional view of across line A-A in FIG. 10;

FIG. 12 illustrates the operation of a bending tool according to the present invention;

FIG. 13a is a schematic view of another embodiment of a bending tool according to the present invention;

FIG. 13b is a cross sectional view across line A-A in FIG. 13a;

FIG. 14 is a cross sectional view of a pelvic endoprosthesis adapted for total-hip replacement;

FIG. 15a is a top view of a selected surface of the endoprosthesis shown in FIG. 14, for connection to the patient's ilium;

FIG. 15b is a perspective view of another embodiment of the surface shown in FIG. 14a;

FIG. 16 is a cross sectional view of another embodiment of a pelvic endoprosthesis adapted for total hip replacement;

FIG. 17a is a view, partially in cross section, of yet another embodiment of a pelvic endoprosthesis adapted for total hip replacement;

FIG. 17b is a cross sectional view of zone I in FIG. 17a;

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention is of a modular implant for pelvis reconstruction which can be adapted to a specific patient during a real-time operation.

Specifically, according to the present invention there is provided an implant which may be used for the replacement of pelvic portions between the acetabulum and the sacrum of a treated patient. A versatile implant according to the present invention is capable of adopting a desired three dimensional shape from a given, preferably flat, configuration by changing the orientation of its surfaces. The shape of such implant can be determined and formed during a real-time operation so as to allow an immediate transplantation.

Further, according to the present invention there is provided an implant which may be used for total hip replacement, wherein reconstruction of the proximal femur and the periacetabular area is needed.

The principles and operation of an implant according to the present invention may be better understood with reference to the drawings and the accompanying description.

Referring now to the drawings, FIGs. 1-5 illustrate an implant according to the present invention, preferably for replacement of pelvic portions between the acetabulum and the sacrum of a patient. As shown in FIG. 1, an implant according to the present invention preferably

includes: a main surface **1** having a stiffening rib **2** disposed along the longitudinal axis of surface **1**; two end surfaces **3** and **4** located at each end of surface 1; and two cantilevers **10** and **11** connected to end surfaces **3** and **4**, respectively. Stiffening rib **2** is preferably of a convexo-concave shape in cross section, as shown in FIG. 2. Preferably, the longitudinal side **19** and the transverse sides **20** and **26** of main surface 1 feature a rounded shape so as to minimize damage to soft tissues. As shown in FIG. 1, cantilevers **10** and **11** are connected to end surfaces 3 and **4**. A slot **5** defines the dimensions and shapes of cantilevers **10** and **11**. Preferably, slot **5** includes a longitudinal portion **6** and a cutout portion **7**, such that the edges **8** and **9** of cantilevers **10** and **11**, respectively, form an angle of between about **60** degrees and about **90** degrees with the edge of longitudinal portion **6**.

As shown in FIG. 3, an implant according to the present invention further includes bending zones, preferably zones **13**, **14**, **15**, **16**, **17** and **18**. Preferably, each of end surfaces **3** and **4** and each of cantilevers **10** and **11** include a group of holes **12** for screws, such that bending zones **13**, **14**, **15**, **16**, **17** and **18** are formed between the groups of holes **12**.

When using an implant according to the present invention, end surfaces 3 and 4 may be bent along any line within the limits of bending zones **13** and **18**, respectively, so as to form an angle of preferably between about 0 and about 30 degrees with main surface **1**.

Cantilever **10**, preferably for attachment to the acetabulum of a patient, may be bent along any line within the limits of each of bending zones **14** and **15**. Preferably, cantilever **10** is bent along a line within the limits of bending zone **14** to form an angle of between about 0 and about 30 degrees with end surface **3**, and along a line within the limits of bending zone **15** to form an angle of between about 0 and about 120 degrees between the two parts of cantilever **10** spaced by bending zone **15**.

Cantilever **11**, preferably for attachment to the sacrum of a patient,

may be bent along any line within the limits of bending zones **16** and **17**. Preferably, cantilever **11** is bent along a line within the limits of bending zone **17** to form an angle of between about 0 and about 30 degrees with end surface **4**, and along a line within the limits of bending zone **16** to form an angle of between about 0 and about 90 degrees between the two parts of cantilever **11** spaced by bending zone **16**.

When bending the implant of the present invention into a three-dimensional shape as described above and attaching the implant to a patient's pelvic area, the load is distributed among screws **25** (FIG. 5) in an optimized manner. Since cantilevers 10 and 11 are bent with relation to main surface 1, screws **25** are not susceptible to harsh transverse forces. Thus, the long-term bio-mechanical stability of the implant is improved.

The edge **21** of cantilever 10 preferably features a rounded shape so as to facilitate the attachment of end surface 3 and cantilever **10** to the acetabulum. The edges **8** and **9** of cantilevers **10** and **11**, respectively, feature a rounded shape so as to minimize damage to soft tissues.

While using an implant according to the present invention, the exact size and three-dimensional shape of the implant required for a specific patient is determined during surgery by using a thin metal template which is easy to bend and is identical in shape and size to the required implant. The template is shaped by the surgeon so as to fit the exact dimensions of the pelvis and sacrum of a given patient after resection. The implant is then shaped according to the template by using a hand bending tool (Figs. 10-13). When fitting the implant to a pelvic area (FIG. 4), cantilever **10** is preferably supported by, and attached to, bony surface **24** formed by the resection of the pelvis, while end surface **3** is supported by, and attached to, bony surface **22** in the immediate proximity of the acetabulum. Cantilever **11** and end surface **4** are preferably supported by, and attached to, bony surface **23** of the sacrum.

The present invention is preferably provided as a set of modular units of templates and pertinent implants of different size, and a hand bending tool for bending the implants. For example, a set of modular units may include templates and pertinent implants having lengths of between about 80 mm and about 140 mm, and graded with differences of about 5-10 mm. The templates and implants are preferably made of stainless steel commonly used for endoprostheses. The method of production used for preparing the implants preferably includes cold stamping and electro-polishing of the implant surface.

Referring now to Figs. 6 and 7, according to another embodiment the implant of the present invention does not include a stiffening rib, but rather includes an extension **30** for conferring a desired stiffness to the implant. As shown in the figures, extension **30** is preferably in the form of a flat surface connected to or integrally made with main surface **1** and extends along its longitudinal axis. Extension **30** is preferably oriented so as to form a predetermined angle with main surface **1**, thereby defining a crest **33** for conferring a desired rigidity to the implant. Extension **30** preferably includes holes **12** for screws. Further, extension **30** preferably includes openings **32** for insertion of medical thread therethrough so as to allow a surgeon to secure the patient's pelvic muscles to the implant by means of stitches, thereby facilitating recovery of the pelvic area.

Referring now to Figs. 8 and 9, according to yet another embodiment extension **30** includes a first surface **30a** and a second surface **30b**, the second surface **30b** being oriented so as to form a predetermined angle with first surface **30b**, thereby defining a crest **30c** therebetween. Preferably, first surface **30a** is oriented so as to form about 90 degrees with main surface **1**. Since such configuration includes a plurality of crests - crest **33** and crest **30**, it features an improved stiffness relative to the configuration shown in Figs. 6 and 7. Further, such configuration enables

to substantially enclose bony portions of the pelvis, thereby allowing to effectively secure the implant to the pelvis.

As shown in Fig. 8, openings **32** for suturing the patient's muscles to the implant are preferably included within main surface **1**.

Referring now to Figs. 10-12, a hand bending tool **40** for shaping an implant of the present invention is shown. As specified above, the exact three dimensional shape of the implant required for a specific patient is determined during surgery by using a thin metal template which is easily bent and shaped by the surgeon. The implant is then immediately shaped according to the template by means of hand banding tool **40**.

As shown in Fig. 10, bending tool **40** preferably includes: an accommodating member **46** including a slot **51** for receiving a selected surface of the implant; and a bending member **48** including a bending extension **53** for bending a portion of the selected surface relative to the rest of the implant while the selected surface is received within slot **51**.

Preferably, accommodating member **46** features a convex edge **50** and bending member **48** features a concave edge **52**, convex edge **50** being received within concave edge **52**, so as to allow sliding of bending member **48** over accommodating member **46**.

As shown in the figure, accommodating member **46** and bending member **48** include respective handles, **47** and **49**, for holding bending tool **40** by a user. Preferably, handles **47** and **49** feature bends, **41** and **42** respectively, for facilitating bending of the implant.

As shown in Fig. 10, slot **51** preferably extends through a portion of the width of accommodating member **46**.

As shown in Fig. 11, slot **51** preferably extends completely through the thickness of accommodating member **46**. Accommodating member **46** and bending member **48** are preferably interconnected by means of a connecting element **54** having a "U" shape, which connecting element being secured to each of members **46** and **48** by means of screws **55**.

Fig. 12 exemplify the operation of a bending tool **40** according to the present invention, wherein cantilever **10** is bent along bending zone **15** as concave bending member **48** slides over convex accommodating member **46**.

Referring now to Fig. 13a, another embodiment of bending tool **40** is shown, wherein bending member **48** includes a pair of bending extensions, **53a** and **53b**, so as to facilitate the manipulation of the implant by means of bending tool **40**. Further, as shown in Fig. 13a, slot **51** preferably extends completely through the width of accommodating member **46** so as to allow symmetrical operation of bending tool **40**.

Thus, for example, cantilever **10** may be bent by means of extension **53a** and cantilever **11** may be bent by means of extension **53b**, thereby enabling symmetrical manipulation of the implant without the need to substantially change the orientation of the implant relative to bending tool **40**.

As shown in Fig. 13b, accommodating member **46** is preferably thick in cross section and slot **51** extends through a portion of the thickness of accommodating member **46**. Connecting member **54** for connecting member **46** and member **48** preferably features an "L" shape, and is secured to each of members **46** and **48** by means of screws **55**.

According to the present invention there is further provided an endoprosthesis which may be used for total hip replacement, wherein reconstruction of the proximal femur and the periacetabular area is needed.

Referring to Fig. 14, a transverse section of a patient's body is shown, wherein a resection of the left pelvic portion has been performed, which resection including the proximal femur, the periacetabular area, the left portion of the pubis, and a portion of the ilium.

As shown in the figure, a pelvic endoprosthesis according to the present invention includes a cup acetabulum prosthesis **70** for receiving a conventional femur prosthesis therein. Prosthesis **70** is mechanically

connected to a first surface **74** by means of a first adapter **72**, and to a second surface **75** by means of a second adapter **73**, the first surface for attachment to the patient's ilium, and the second surface for attachment to the right portion of the patient's pubis.

As shown in the figure, cup acetabulum prosthesis **70** and first adapter **72** are interconnected by means of screws **77**; first adapter **72** and first surface **74** are interconnected by means of screws **78**; and first surface **74** is secured to the patient's ilium by means of screws (not shown in the figure).

Further as shown in the figure, cup acetabulum prosthesis **70** and second adapter **73** are interconnected by means of screws **77**; second adapter **73** and second surface **75** are interconnected by means of screws **76**; and second surface **75** is secured to the left portion of the patient's pubis by means of screws **79**.

Cup acetabulum prosthesis **70** may feature specific sizes. Further, adapters **72** and **73** may feature specific dimensions and shapes so as to allow adaptation of the prosthesis to different patients.

First and second surfaces **74** and **75** may be shaped by means of hand bending tool **40** so as to adopt a specific three dimensional shape, as required.

The exact three dimensional shapes of first and second surfaces **74** and **75** are determined during surgery by using a thin metal template which is easily bent and shaped by the surgeon. Surfaces **74** and **75** are then immediately shaped by means of hand banding tool **40**.

Figs. 15a and 15b show possible configurations of first surface **74**. Surface **74** preferably includes two bending zones, **92a** and **92b**, extending along the longitudinal axis of surface **74**, along which surface **74** is bent by bending tool **40**. Such configuration allows to substantially enclose a bony portion of the patient's ilium so as to effectively fix surface **74** thereto. As shown in the figures, surface **74** preferably includes holes **12**

for screws, the screws for securing surface **74** to the patient's ilium. Preferably, surface **74** includes a plurality of circumferential protrusions **91** separated by depressions **90** such that each of holes **12** is located on a distinct protrusion. As shown in Fig. 15b, each of circumferential protrusions **91** may be independently bent along a specific protrusion bending zone **93**, thereby enabling to specifically adapt surface **74** to a specific bone structure.

Surface **75** may feature a similar configuration as shown for surface **74**.

Fig. 16 shows another embodiment of a pelvic endoprosthesis according to the present invention. As shown in the figure, the patient's ilium has been resected, and first surface **74** extends to reach the patient's sacrum and is preferably connected to the patient's sacrum by means of screws (not shown in the figure). When using such embodiment, surface **74** may include a cantilever element, substantially as shown in Fig. 4.

Referring to Figs. 17a and 17b, according to another embodiment the orientation of cup acetabulum prosthesis **70** is adjustable so as to prevent displacement of the femur prosthesis.

As shown in the figures, cup acetabulum prosthesis **70** preferably includes a hollow cylindrical extension **85** received within a hollow cylindrical chamber of adapter **72**. Thus, cup acetabulum prosthesis **70** may be rotated along the longitudinal axis of cylindrical extension **85** (designated as A) by rotating cylindrical extension **85** within the hollow cylindrical chamber of adapter **72**. Since cup acetabulum prosthesis **70** is unsymmetrical with reference to longitudinal axis A (best shown in FIG. 17a), such rotation results in changing the orientation of cup acetabulum prosthesis **70** relative to adapter **72**. Lock screw **80** is used to fix cup acetabulum prosthesis **70** at a desired position.

As shown in the figure, adapter **72** is preferably connected to surface **74** by means of an excentric pin **82**. Such connection allows to

slightly change the orientation of adapter **72** with reference to surface **74**, substantially as designated by arrow B. Lock screw **84** is used to fix adapter **72** at a desired position.

While the invention has been described with respect to a limited number of embodiments, it will be appreciated that many variations, modifications and other applications of the invention may be made.

WHAT IS CLAIMED IS:

1. An implant for replacement of a region of a pelvic bone by connecting a first portion and a second portion of the pelvic bone, comprising:

(a) a main surface for connecting the first portion of the pelvic bone and the second portion of the pelvic bone;

(b) at least one end surface connected to said main surface; and

(c) at least one primary bending zone located between said main surface and said at least one end surface for changing the orientation of said at least one end surface relative to said main surface.

2. The implant of claim 1, wherein the implant includes a first end surface and a second end surface, said first end surface for connection to the first portion of the pelvic bone and said second end surface for connection to the second portion of the pelvic bone.

3. An implant for replacement of a region of a pelvic bone by connecting an acetabulum and a sacrum of a patient, comprising:

(a) a main surface for connecting the acetabulum and the sacrum;

(b) a first end surface and a second end surface connected to said main surface; and

(c) primary bending zones located between said main surface and each of said end surfaces.

4. The implant of claim 1, further comprising:

(a) at least one cantilever element connected to said at least one end surface; and

(b) at least one secondary bending zone located between said at least one end surface and said at least one cantilever element for changing the orientation of said at least one cantilever element relative to said at least one end surface.

5. The implant of claim 4, wherein said at least one cantilever element includes at least one tertiary bending zone for changing the orientation of a portion of said cantilever element.

6. The implant of claim 5, wherein said implant includes a first cantilever element connected to a first end surface and a second cantilever element connected to a second end surface, said first cantilever element for connection to the first portion of the pelvic bone and said second cantilever element for connection to the second portion of the pelvic bone.

7. The implant of claim 3, further comprising:

(a) a first cantilever element connected to said first end surface and a second cantilever element connected to said second end surface, said first cantilever element for connection to the acetabulum and said second cantilever element for connection to the sacrum; and

(b) two secondary bending zones, each of which being located between a cantilever element and a respective end surface.

8. The implant of claim 7, wherein each of said cantilever elements includes a tertiary bending zone.

9. An implant for replacement of a region of a pelvic bone by connecting a first portion and a second portion of the pelvic bone, comprising:

(a) a main surface for connecting the first portion of the pelvic bone and the second portion of the pelvic bone;

(b) at least one cantilever element connected to said main surface; and

(c) at least one primary bending zone located between said main surface and said at least one cantilever element for changing the orientation of said at least one cantilever element relative to said main surface.

10. The implant of claim 9, wherein said at least one cantilever element includes at least one secondary bending zone for changing the orientation of a portion of said cantilever element.

11. The implant of claim 1, wherein said at least one end surface is bent along a line within the limits of said at least one primary bending zone so as to form an angle of between about 0 and about 30 degrees with said main surface.

12. The implant of claim 4, wherein said at least one cantilever element is bent along a line within the limits of said at least one secondary bending zone so as to form an angle of between about 0 and about 30 degrees with said at least one end surface.

13. The implant of claim 5, wherein said portion of said at least one cantilever element is bent along a line within the limits of said at least one tertiary bending zone so as to form an angle of between about 0 and about 90 degrees with the rest of said cantilever element.

14. The implant of claim 5, wherein said portion of said at least one cantilever element is bent along a line within the limits of said at least one tertiary bending zone so as to form an angle of between about 0 and about 120 degrees with the rest of said cantilever element.

15. The implant of claim 1, wherein said implant includes a stiffening rib.

16. The implant of claim 15, wherein said stiffening rib has a convexo-concave shape in cross section.

17. The implant of claim 1, wherein said implant includes holes for screws.

18. The implant of claim 6, wherein the dimensions and shapes of said cantilever elements are defined by a slot having a longitudinal portion and a cut-out portion.

19. The implant of claim 1, wherein said implant features a longitudinal side.

20. The implant of claim 19, wherein said implant further comprising an extension extending substantially along said longitudinal side, said extension being oriented so as to form a predetermined angle with said main surface, thereby forming a stiffening crest between said main surface and said extension.

21. The implant of claim 20, wherein said extension features a longitudinal bend extending along the longitudinal axis of said extension, said bend defining a first portion and a second portion of said extension

such that said second portion being oriented so as to form a predetermined angle with said first portion, thereby enabling to substantially enclose a portion of the patient's pelvis.

22. The implant of claim 20, further including openings for receiving a thread therein so as to allow to suture patient's muscles to said implant.

23. A bending tool for bending a pelvic implant, comprising:

(a) an accommodating member having a slot for receiving a surface of the implant therein;

(b) a bending member having at least one bending extension for bending a portion of the surface,

said accommodating member featuring a convex surface and said bending member featuring a concave surface so as to allow sliding of said bending member over said accommodating member.

24. The bending tool of claim 23, wherein said slot extends completely through the thickness of said accommodating member.

25. The bending tool of claim 23, wherein said slot extends through a portion of the thickness of said accommodating member.

26. The implant of claim 1, wherein said at least one end surface includes at least one circumferential protrusion, said at least one protrusion including a hole for receiving a screw therein, said at least one protrusion including a bending zone for individually bending said at least one protrusion relative to said at least one end surface.

27. An implant for replacement of a pelvic bone by connecting a first portion and a second portion of the pelvic bone, comprising:

(a) a cup acetabular prosthesis;

(b) a first main surface for connecting the first portion of the pelvic bone to said cup acetabulum prosthesis;

(c) a second main surface for connecting the second portion of the pelvic bone to said cup acetabulum prosthesis,

wherein each of said first and second main surfaces includes:

(i) at least one end surface connected thereto; and

(ii) at least one bending zone located between said main surface and said at least one end surface for changing the orientation of said at least one end surface relative to said main surface.

28. The implant of claim 27, wherein said at least one end surface includes at least one circumferential protrusion, said at least one protrusion including a hole for receiving a screw therein, said at least one protrusion including a bending zone for individually bending said at least one protrusion relative to said at least one end surface.

29. The implant of claim 27, wherein said first main surface is connected to said cup acetabulum prosthesis by means of a first adapter, and said second main surface is connected to said cup acetabulum prosthesis by means of a second adapter.

30. The implant of claim 29, wherein said cup acetabulum prosthesis includes a protrusion and wherein at least one of said adapters includes a depression for accommodating said protrusion therein, and

wherein said protrusion is movable within said depression, thereby allowing to change the orientation of said cup acetabulum prosthesis relative to said at least one adapter.

31. The implant of claim 30, further including a lock screw for fixing the position of said cup acetabulum prosthesis with relation to said at least one adapter.

32. The implant of claim 29, wherein said first adapter is movable with relation to said first main surface.

33. The implant of claim 32, wherein said first adapter is connected to said first main surface by means of an excentric pin.

34. The implant of claim 33, wherein said implant further includes a screw lock for fixing the position of said first adapter with relation to said first surface.

35. The implant of claim 27, wherein the first portion of the pelvic bone includes the patient's ilium.

36. The implant of claim 27, wherein the first portion of the pelvic bone includes the patient's sacrum.

37. The implant of claim 27, wherein the second portion of the pelvic bone includes the patient's pubis.

38. A method for reconstructing a region of a pelvic bone, comprising:

(a) resecting a portion of the pelvic bone;

(b) manually shaping a substantially flexible template so as to connect selected remaining portions of the pelvic bone;

(c) substantially immediately shaping a pelvic implant according to the shape of said template by means of a bending tool; and

(d) connecting said implant to the selected remaining portions of the pelvic bone.

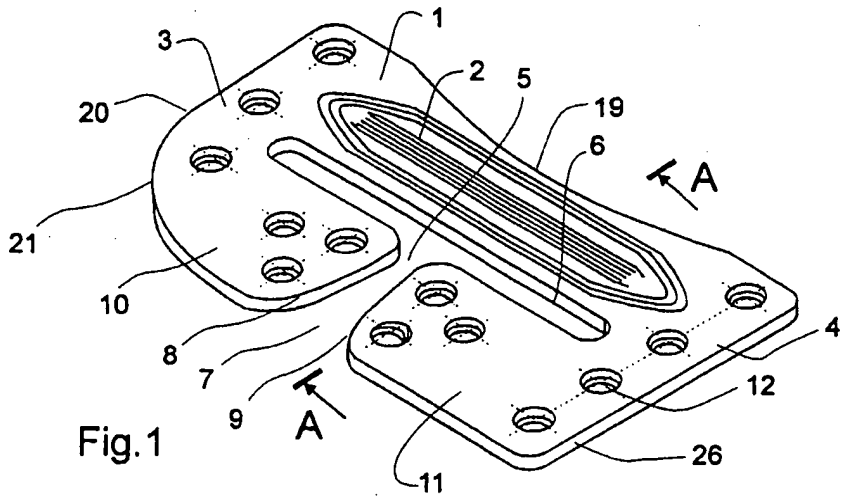

Fig.1

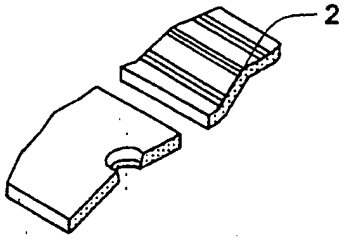

Fig. 2

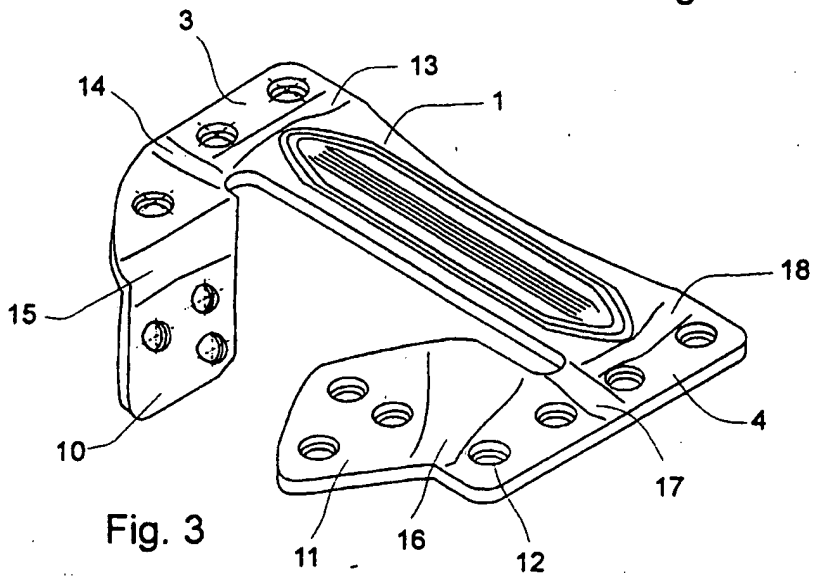

Fig. 3

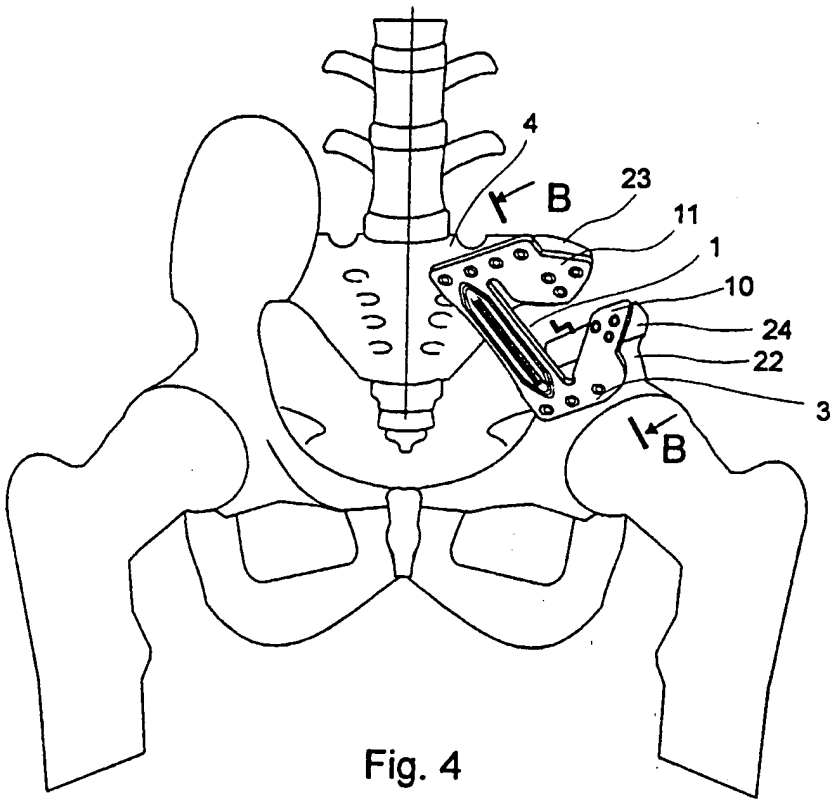

Fig. 4

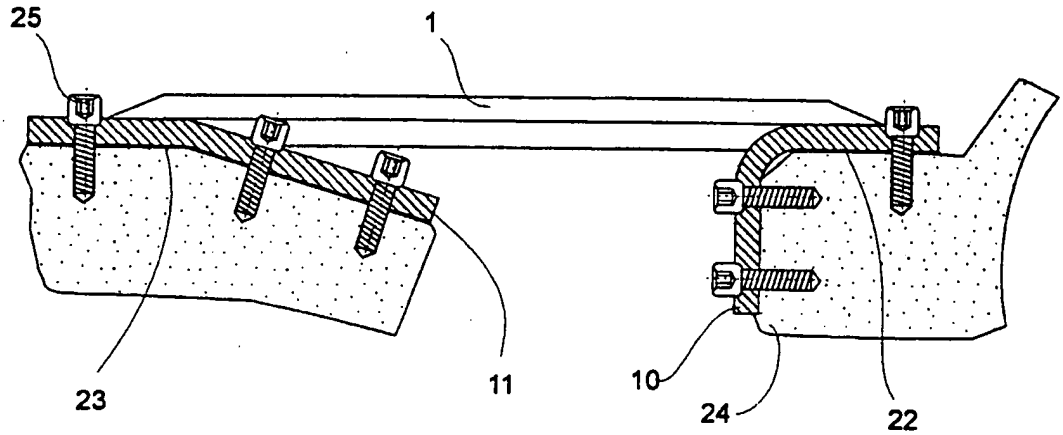

Fig. 5

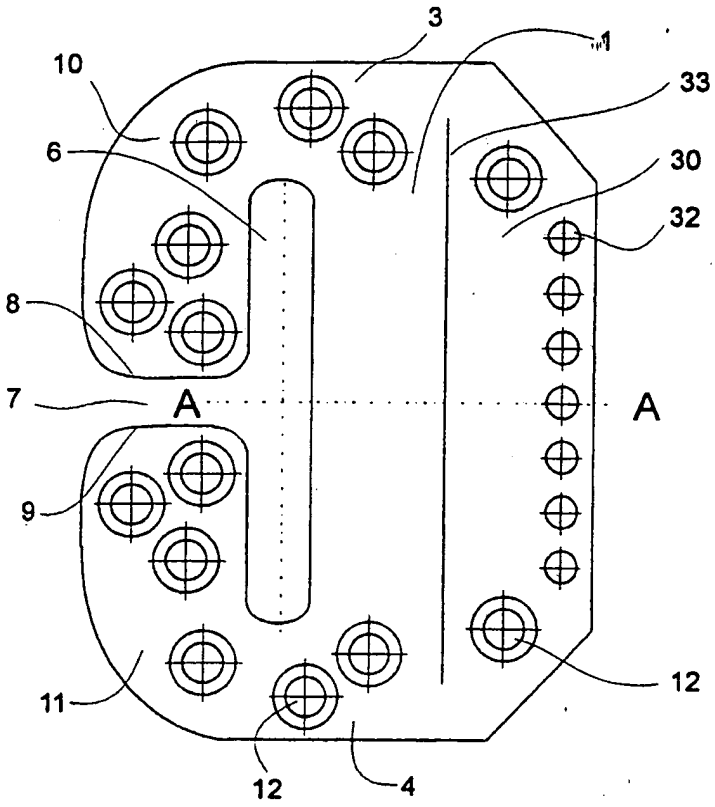

Fig. 6

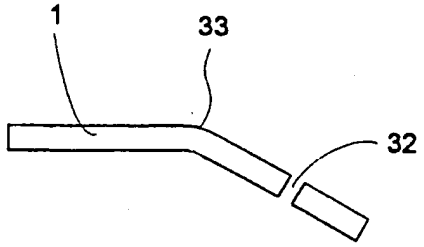

Fig. 7

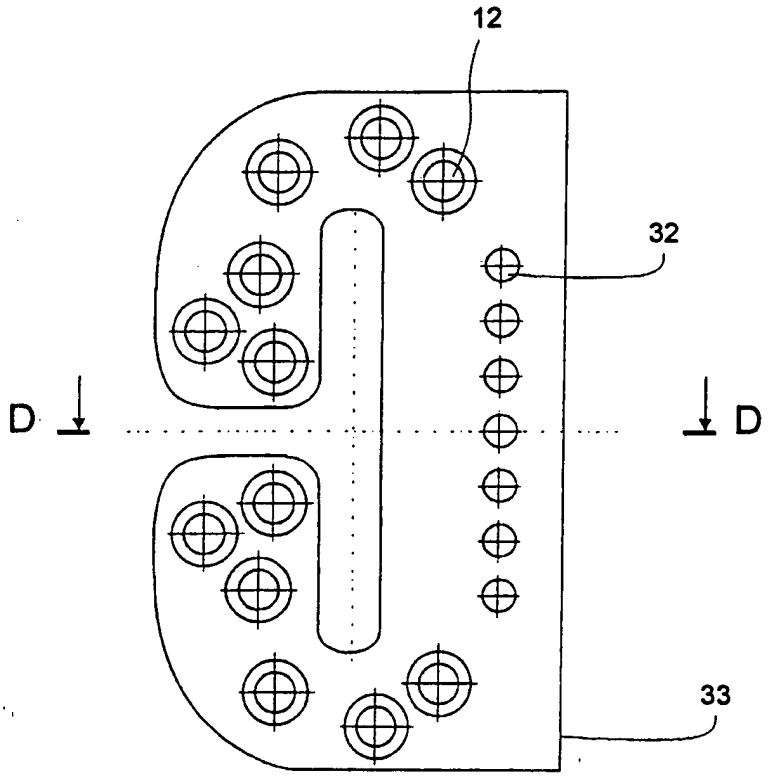

Fig. 8

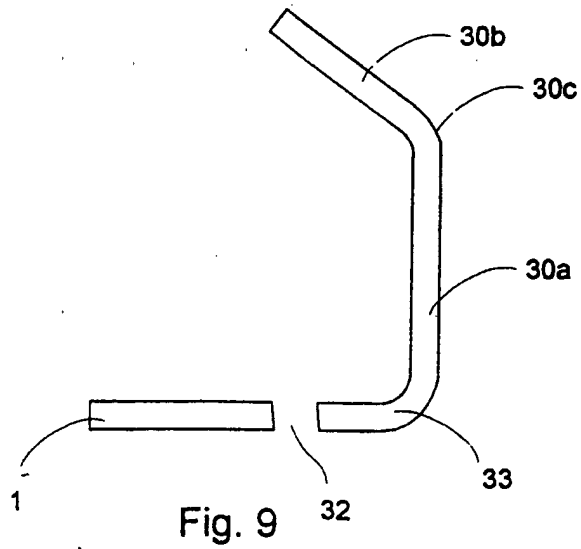

Fig. 9

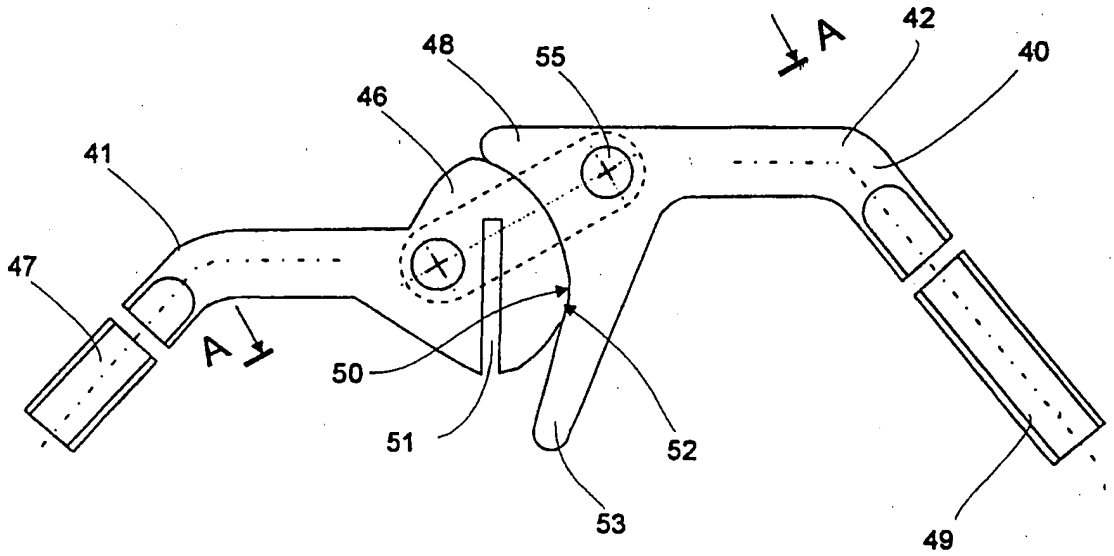

Fig. 10

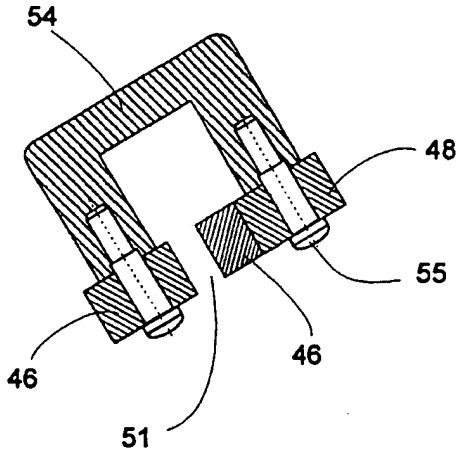

Fig. 11

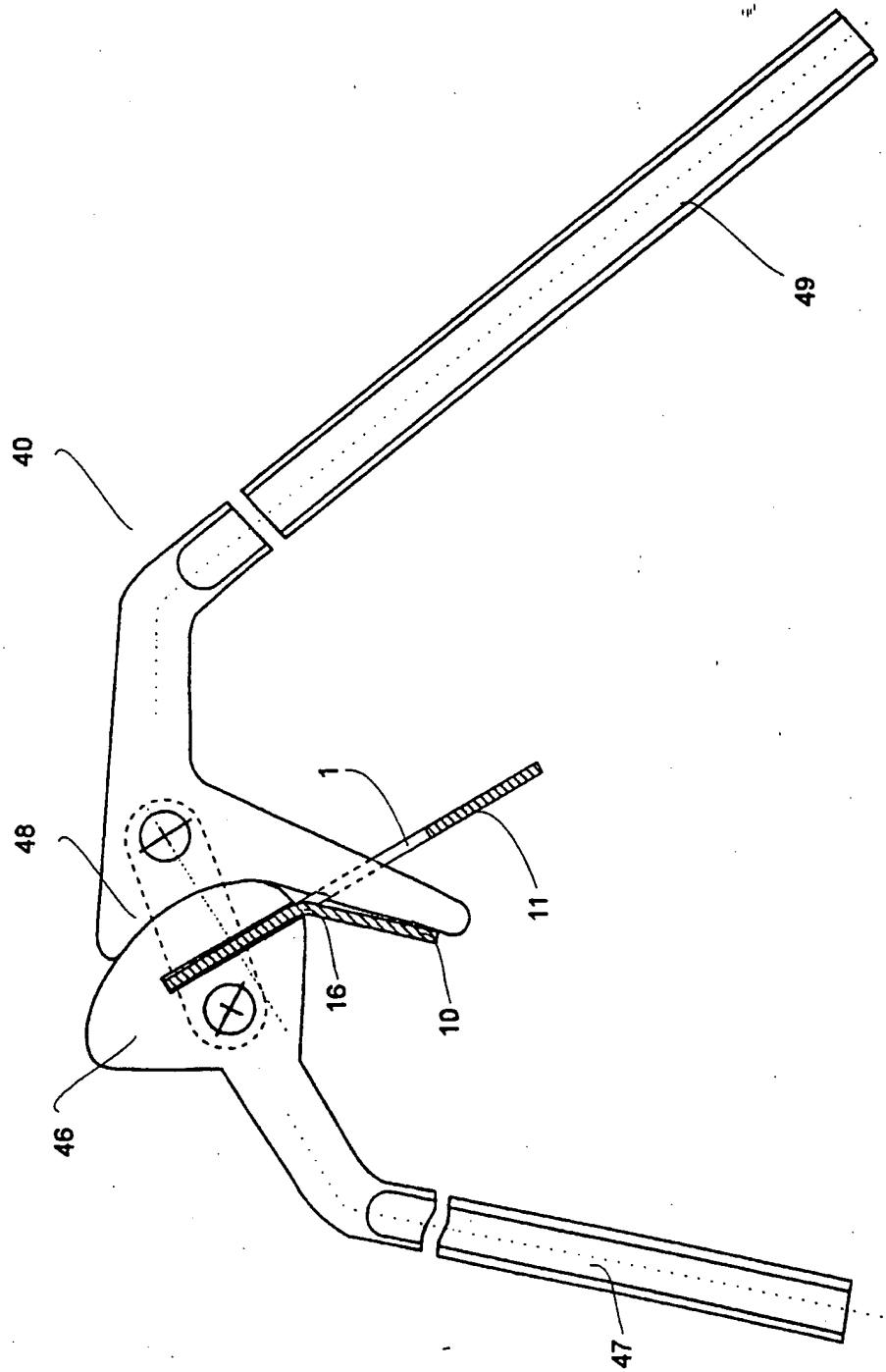

Fig. 12

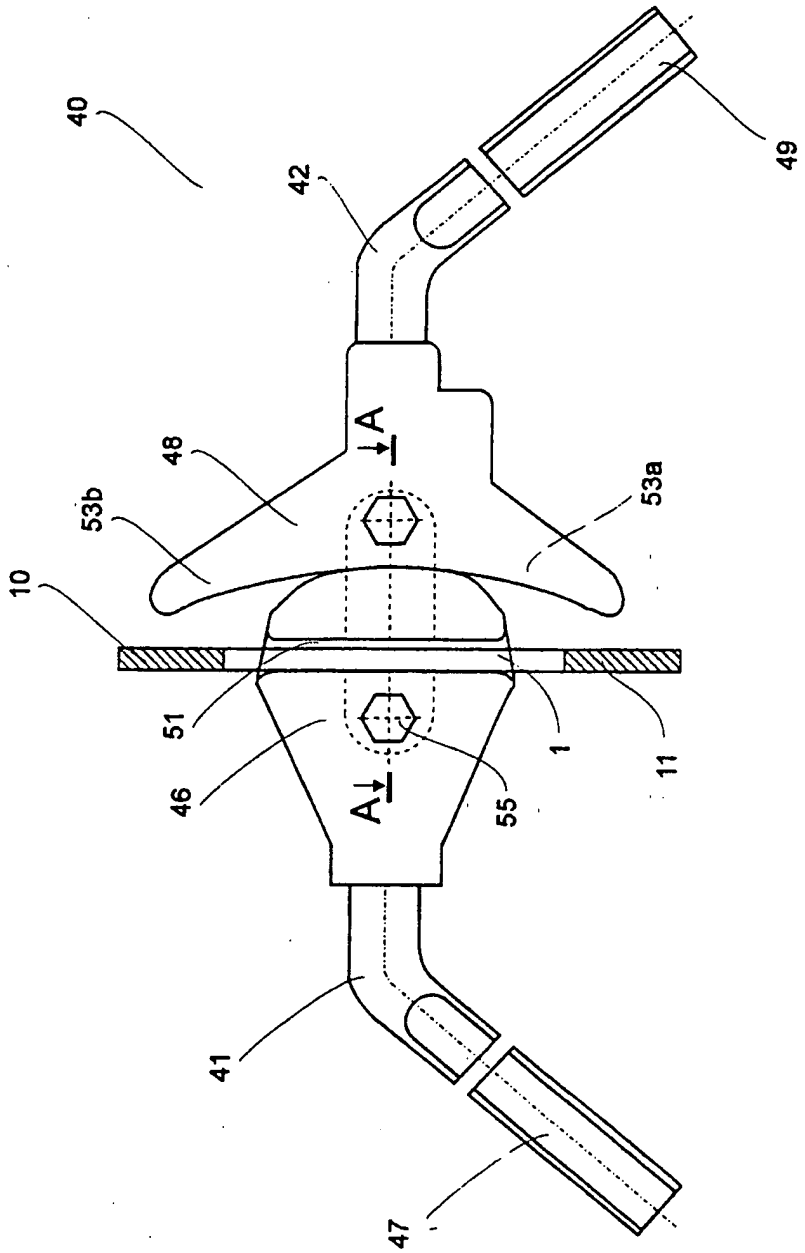

Fig. 13a

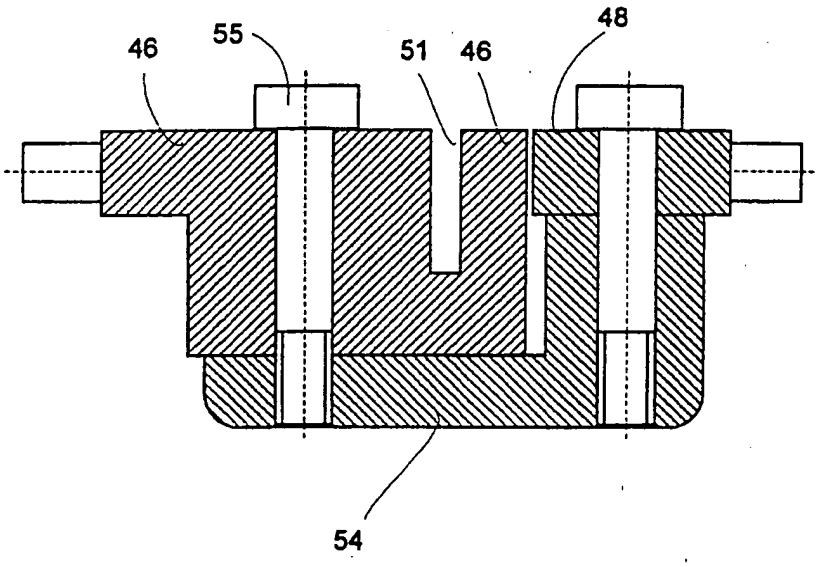

Fig. 13b

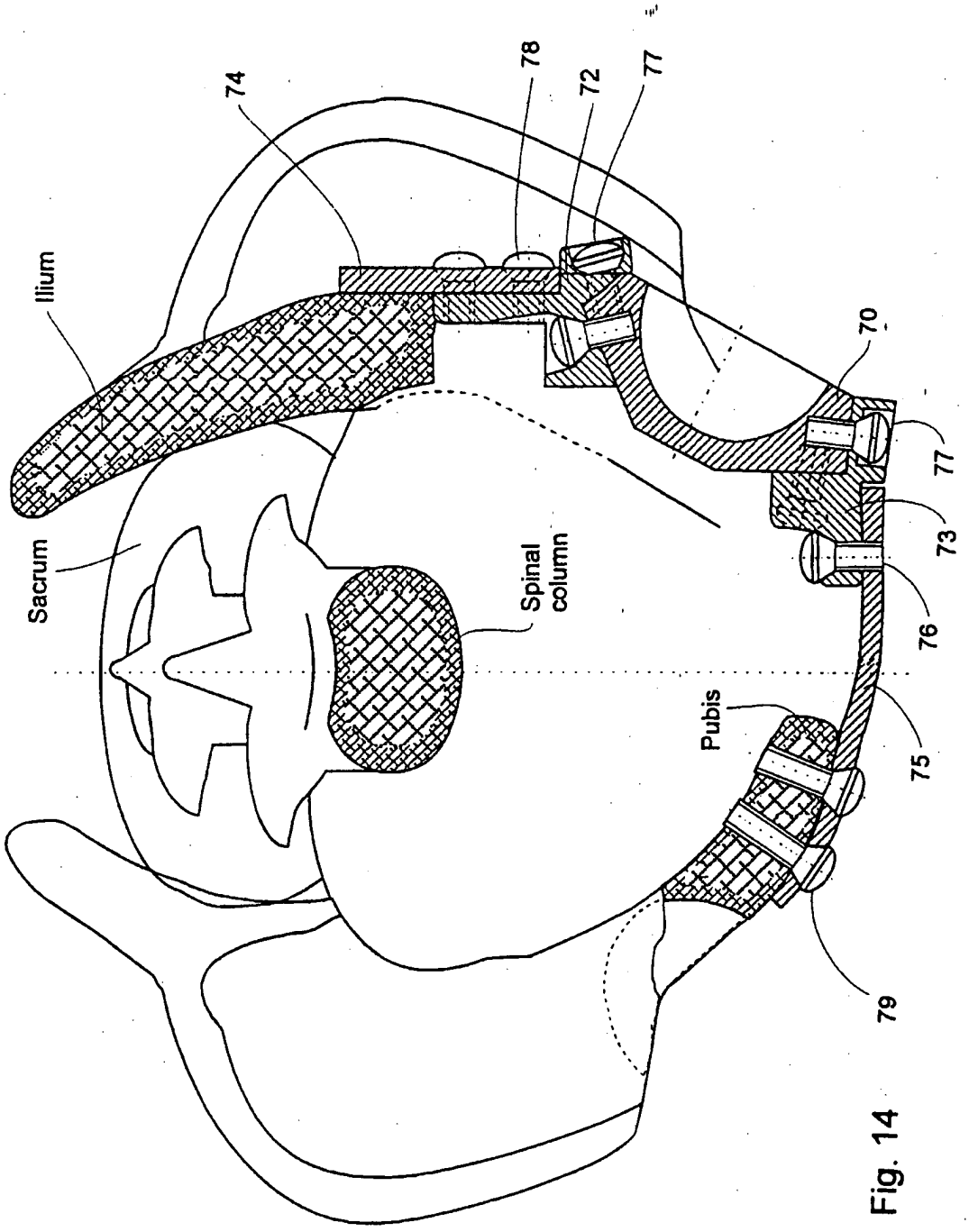

Fig. 14

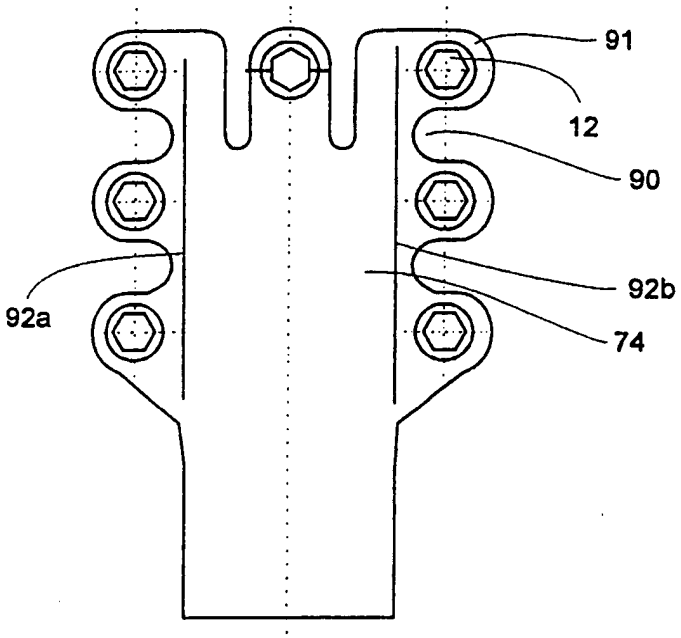

Fig. 15a

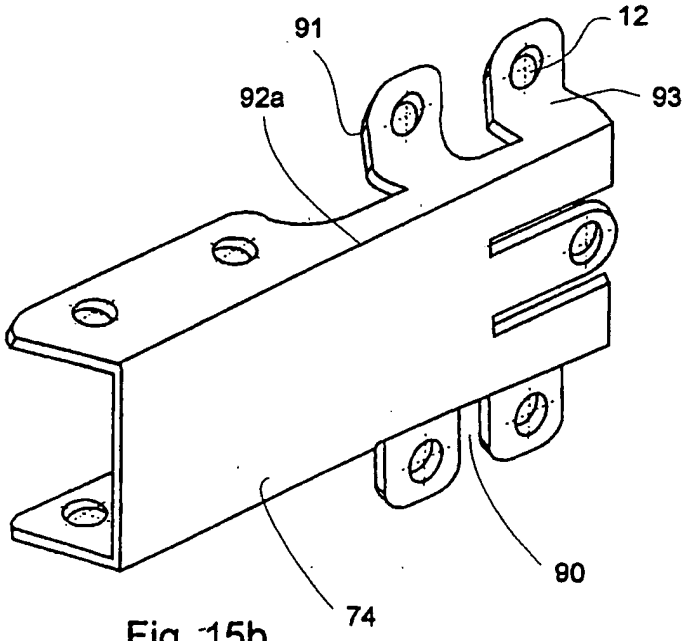

Fig. 15b

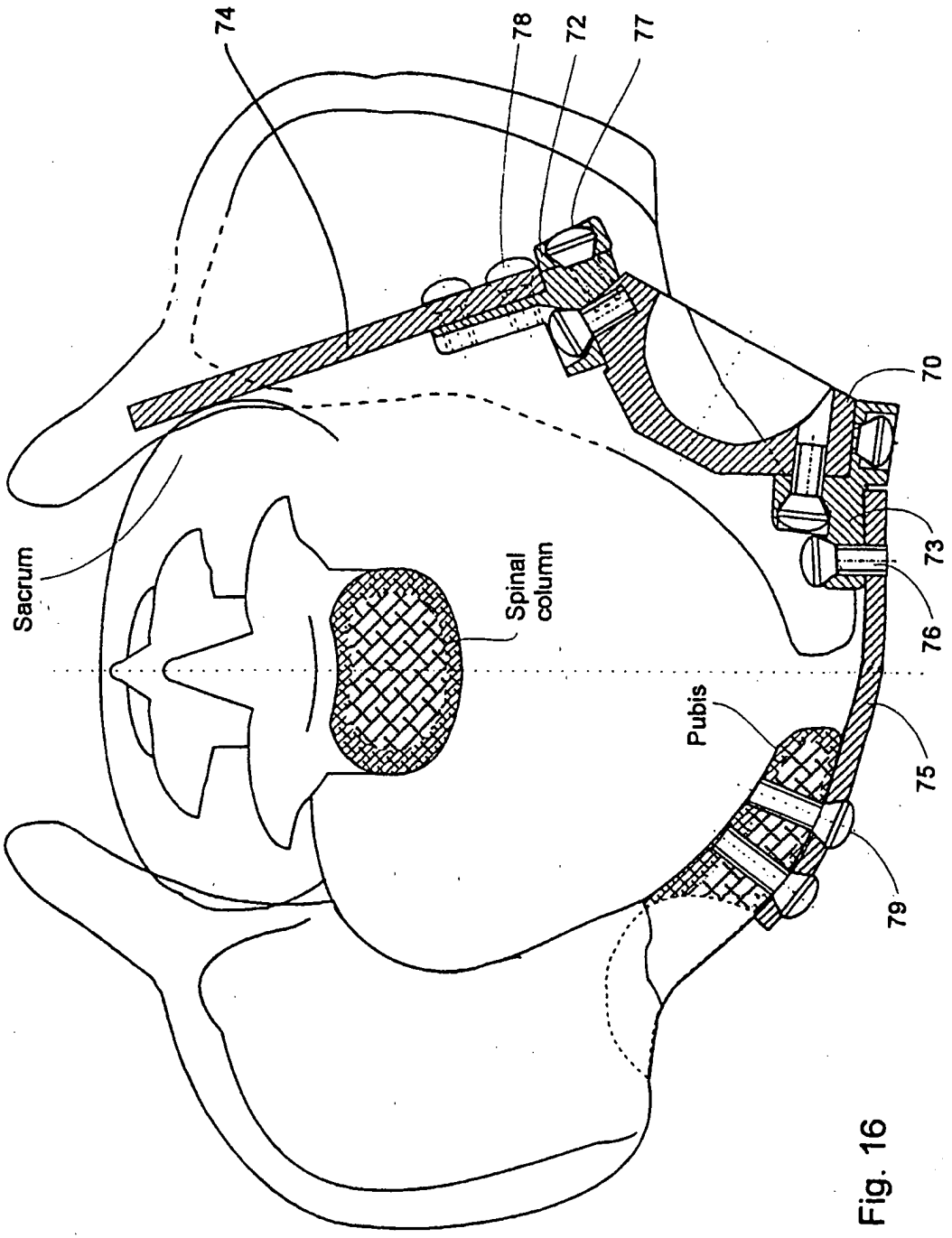

Fig. 16

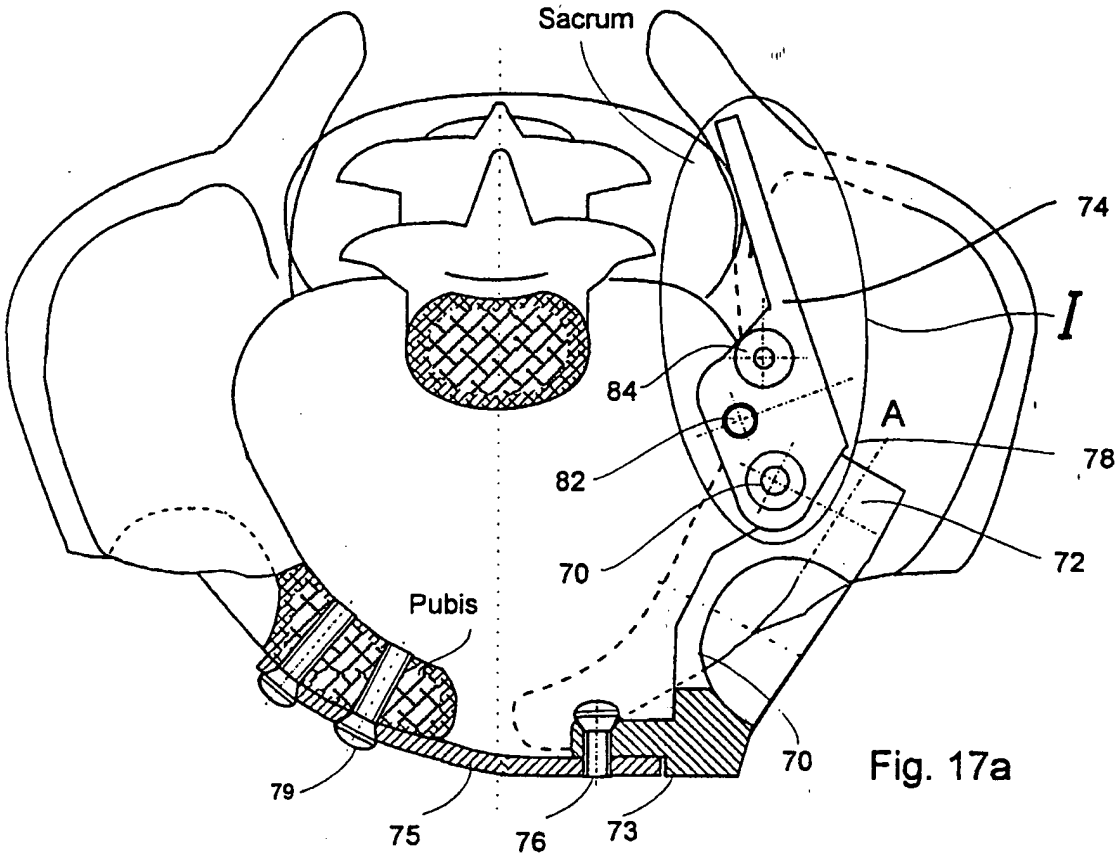

Fig. 17a

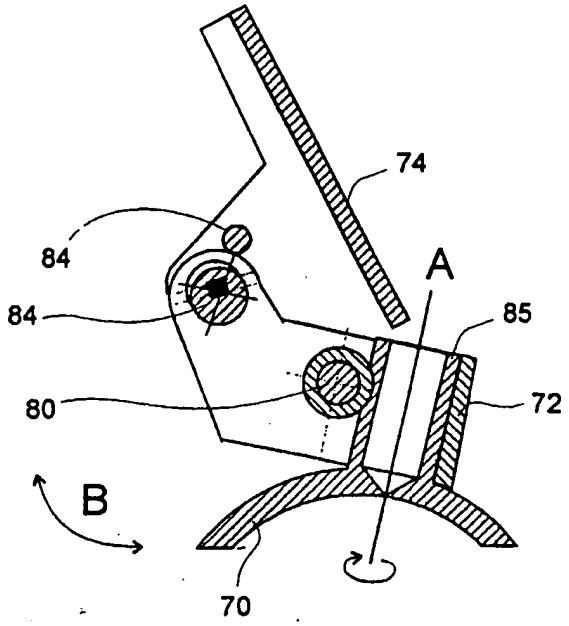

Fig. 17b

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IL97/00305

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :A61F 2/32
US CL :72/458; 623/22
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 623/22, 16, 18; 72/458, 459; 606/69, 70, 71, 101

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

NONE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,326,367 A (ROBIONECK) 05 July 1994, Fig. 1, and all elements are capable of being bent.	1-14, 17-19, 26-31, 38
X	US 5,314,490 A (WAGNER et al) 24 May 1994, figures. Note the end element has two bending zones. The outer most part is interpreted as the cantilever element. The implant inherently has an acetabular cup.	1-14, 17-19, 26-31, 35-37
X	US 1,506,096 A (STIDWORTHY) 11 April 1923, figures. Note concavex element (40) of Fig. 7. The accommodating member includes element (10)(13)-(15;. The slot is the space between elements (10)(13). The bending member having a concave surface (40) includes element (36).	23-25

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search 09 DECEMBER 1997	Date of mailing of the international search report 14 JAN 1998
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3590	Authorized officer BRUCE SNOW Telephone No. (703) 308-0858

Form PCT/ISA/210 (second sheet)(July 1992)*

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IL97/00305

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	RU 2014034 (AXMETOB et al) 15 June 1994, Fig. 1.	23-25
A	US 468,584 A (SYMONDS) 09 February 1892, all figures.	23-25
A	US 3,750,447 A (KOWAL ET AL) 07 August 1973, entire document.	23-25
A	US 5,030,238 A (NIEDER ET AL) 09 June 1991, entire document.	1-22, 26-38
A	DE 41 33 437 (SCHELHAS et al) 19 May 1993, see entire document.	1-22, 26-38
A	US 4,883,489 A (GRUNDEI et al) 28 November 1989, entire document.	1-22, 26-38